THE VARIATIONS OF EUTÆNIA IN THE PACIFIC SUBREGION.

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The portion of the Pacific coast of North America occupied by the garter snakes extends from about latitude 50° in British Columbia to the neighborhood of 33° in southern California,[1] and exhibits great variety of soil and climate, especially in the extremes of dryness and humidity. The annual rainfall at Puget Sound has reached a hundred and thirty inches, while at Yuma, in southeastern California, the average is little more than three. Under these circumstances, and having in mind the ease with which color in reptiles is acted upon by external conditions, of which there is reason to believe that moisture is one of the most active, it is not surprising that color variation should reach a maximum in a group of snakes which, through diversity of habit, occupy practically every station open to their kind. Many species and subspecies have been established from this region upon examples so few in number as to form an altogether inadequate foundation in a genus where the range of variation is as great as it is known to be in *Eutænia*—or is known, at least, to all but those naturalists who establish uniformity by the easy process of attaching a name to every difference, without regard to its nature or its biological significance.

Efforts to bring these supposed forms into some sort of order have been made in late years by Mr. G. A. Boulenger,[2] Mr. John Van Denburgh[3] and the present writer,[4] but it must be admitted that the assignment of some intermediates has been accomplished in part by the exercise of that mode of judgment which has been termed "the naturalist's instinct." Some material now in my possession bears directly upon the questions of identity involved in *E. elegans* and *E. infernalis*, and their interesting character has led me to review all the garter snakes of the region in question.

The list following contains the names of all the species and subspecies within my knowledge, with the date of establishment and the

[1] *Eutænia eques* Reuss. has been found in the peninsula of Lower California, and others may yet be taken in that little-known region.

[2] *Catalogue of Snakes in British Museum*, Vol. I, p. 192, *et seq.* (1893).

[3] *Occasional Papers California Academy of Sciences*, V, p. 199, *et seq.* (1897).

[4] *Proceedings Academy of Natural Sciences of Philadelphia*, 1901, p. 18, *et seq.*

type locality, which have been founded upon snakes belonging to the genus from this region, or whose range has been extended to enter it. Those admitted here are printed in capitals:

COLUBER PARIETALIS Say (1823). Missouri river near Council Bluffs.
Coluber infernalis Blain. (1835). California.
Tropidonotus ordinoides B. and G. (1852). Puget Sound.
Tropidonotus concinnus Hallow. (1852). Oregon.
EUTÆNIA PICKERINGI B. and G. (1853). Puget Sound.
EUTÆNIA LEPTOCEPHALA B. and G. (1853). Puget Sound.
Eutænia dorsalis B. and G. (1853). Rio Grande, Texas.
EUTÆNIA ELEGANS B. and G. (1853). El Dorado county, Cal.
EUTÆNIA VAGRANS B. and G. (1853). California.
Tropidonotus trivittatus Hallow. (1853). California.
Eutænia couchi Kenn. (1857). Pitt river, Shasta county, Cal.
Eutænia atrata Kenn. (1860). California.
Eutænia cooperi Kenn. (1860). Washington (?).
EUTÆNIA HAMMONDI Kenn. (1860). San Diego county, Cal.
E. sirtalis tetratænia Cope (1875). Pitt river and Puget Sound.
Eutænia henshawi Yarrow (1884). Walla Walla, Wash.
EUTÆNIA BISCUTATA Cope (1883). Klamath Lake, Oregon.
E. elegans plutonia Cope (1892)=type of *E. henshawi* Yarr.
E. elegans brunnea Cope (1892). Fort Bidwell, Cal.
E. elegans lineolata Cope (1892). No definite type.
E. infernalis infernalis Cope (1892). Fresno and San Francisco.
E. infernalis vidua Cope (1892)=types of *E. atrata* Kenn.
E. sirtalis trilineata Cope (1892). Port Townsend, Ore.

These names, twenty-three in number, appear to me to be reducible to three species, two of which present three forms each, sufficient in number and constant enough in character, or so associated with a restricted area of distribution as to compel recognition as subspecies; or seven forms in all,[5] the special features of which are capable of being arranged in a key which will cover all cases but the few anomalies upon which individual judgment is required.

A.—Scales in 21 rows; upper labials 8:

a.—Body moderately stout; head and eye rather small; posterior chin-shields equal or very little longer than anterior (*E. elegans*):

[5] Mr. Van Denburgh admits the same forms, but like values are not attached to them in all cases. Mr. Boulenger reduces them still further to five. As the only purpose of this paper is to analyze the various type specimens, no attempt is made to give references beyond the original descriptions.

a'.—Usually 1 preocular:
Black with three light stripes; or brown or red with stripes and spots distinct; no nuchal blotches; head smaller, ... *E. e. elegans.*
Greenish-olive; stripes and spots not very distinct; nuchal blotches often present; ventrals often dark; head larger, ... *E. e. vagrans.*
b'.—Usually 2 preoculars; often 23 rows; color like *vagrans* or darker, ... *E. e. biscutata.*
b.—Body slender; posterior chin-shields much longer than anterior; brown, usually without stripes; spots small and irregular, ... *E. hammondi*
B.—Scales in 19 rows; upper labials 7; posterior chin-shields much longer than anterior (*E. sirtalis*):
a.—Body stout; head moderately large:
Brown or black; upper row of spots often fused into a stripe; usually red on sides, ... *E. s. parietalis.*
Usually black, with three light stripes, . . *E. s. pickeringi.*
b.—Body small; head and eye small; often 17 rows and 6–8 labials; color variable, ... *E. s. leptocephala.*

Eutænia elegans.

Baird and Girard, Catalogue of North American Serpents, p. 34 (1853).

This species has in nearly every case 8 upper labials and 21 rows of scales, of which the outer is either smooth or very faintly keeled, but an occasional example has 19 rows, or in one form 23, and the labials are sometimes 7. Lateral stripe on the second and third rows. The head is small and delicately formed; the eye moderately small, and the posterior chin-shields are about equal to the anterior ones or very little longer. The throat and chin are almost invariably yellowish. It is to be observed that two species found together in California, *E. elegans* and *E. sirtalis parietalis*, occasionally exhibit the scale and labial formula of the other, and very rarely the former may have posterior chin-shields as long as the shortest of the latter, and a very similar color variety occurs in each; but when *elegans* has 19 rows or 7 labials it may almost always be distinguished from any form of *E. sirtalis* by its short hinder chin-shields, and from any but *E. s. leptocephala* by its small head and eye.

Three subspecies are to be admitted.

Eutænia elegans elegans.

Eutænia elegans B. and G., Cat. No. Am. Serp., p. 34 (1853).
Tropidonotus trivittatus Hallow., Proc. Acad. Nat. Sci. Phila., 1853, p. 237.
E. elegans lineolata (part) Cope, Proc. U. S. Nat. Mus., XIV, p. 655 (1892).
E. infernalis infernalis Cope, *l. c.*, p. 657 (not *Coluber infernalis* Blain.).

Baird and Girard's type of *E. elegans* was almost black in color, with

the three light stripes well defined, and had 21 rows of scales; their second specimen had 19 rows and the dorsal spots were visible against the dark ground.

Seven living garter snakes received at the Zoological Gardens of Philadelphia in May, 1902, from a collector at Oakland, Cal., throw much light upon the variations of this form.

Specimens *a*, *b*, *c*, *d*, measuring from 270 to 290 mm. in length, correspond in color to typical *elegans*, the three pale yellow stripes being on a brownish-black ground so dark that the spots are barely visible. Two have 21 dorsal rows and 8 upper labials; one has them 21 and 7; one has 19 and 8.

The three others are of mature size and much significance.

Specimen *e*, 733 mm. long (tail 175), has 19 rows of scales, the outer weakly keeled, and 8 labials. Ventrals 163; subcaudals 87. The whole dorsal color between the spots, more or less of the outer row of scales, and the entire center of the belly are bright red. The spots are distinct and number about 94 in each row, to the vent. The dorsal stripe is orange-yellow and the laterals paler, more buff, but much marked with red. The small parietal spots and those on the ends of the ventrals, common in many species, are present and the upper portion of the labial sutures are slightly margined with dark shading. The portion of the ventral surface not red is pale green. This specimen is the most brilliant and beautiful *Eutænia* I have ever seen.

Specimen *f*, 800 mm. long (tail 184), has 19 rows of scales, the outer faintly keeled, or smooth in places; 8 upper labials which are yellowish-olive slightly bordered with black. Ventrals 168; subcaudals 72. The dorsal stripe is bright yellow, and the laterals red. Body color dark brownish-black, the upper row of spots being entirely obscured, the lower row, 84 in number, showing as downward prolongations of the black from above, and separated by not very distinct patches of red just above the lateral stripe. This portion of the color pattern closely resembles some examples of *E. s. parietalis*. The belly is yellowish-olive in the center, slightly marked with red, the pattern of this part corresponding exactly to that colored red in *e*. The ends of the ventrals and the outer row of scales are olive-brown. No parietal spots and no distinct spots on the ends of the ventrals, but their bases are slightly dusky. This snake is *E. infernalis infernalis* Cope.

Specimen *g*, 880 mm. long (tail 210), has 21 rows, the outer partly keeled and partly smooth, and 8 upper labials. Ventrals 167; subcaudals 72. In pattern it is like *e*, but the body color is mostly brown instead of red, this last showing only on a single scale here and there,

especially on the lateral stripe. There are about 90 spots in each row, the upper not very distinct. The belly is pale olive with small spots on the ends of many ventrals. No parietal spots and the labials very slightly margined. All these specimens have the small fine head, the short posterior chin-shields and the yellow throat and chin of *E. elegans*, and notwithstanding their wide difference in color, their specific unity is established by the fortunate fact that specimen *g* was a female, gravid at the time of death, and I removed from her thirteen young, twelve of which are typical *elegans* in color, being so dark that the spots are barely visible, and corresponding exactly to specimens *a*, *b*, *c*, *d*. The thirteenth is also dark, but when first taken from the mother showed red markings on the flanks like those of specimen *f*. This red has almost entirely disappeared after twelve weeks in spirits. All of these young snakes have 21 rows of scales; ten have 8 labials; three have 7 on one side. The temporals range from 1–2–3 to 2–3–1. We have, then, unborn young exhibiting the colors of *elegans* B. and G. and *infernalis infernalis* Cope, the one resembling the latter having the scales and labials of *elegans*, contained in the oviducts of a female which, differing from both in color, departs in no other way from the features of *elegans*. If the red, which is a purely individual acquisition, were omitted, specimen *g* would come very close to *E. e. lineolata* Cope, some of which are referable to the present subspecies and some to *E. e. vagrans*.

Tropidonotus trivittatus Hallow. is no more than a typical *elegans* with 19 rows.

E. e. elegans appears to occur only in California, from Shastha in the north down to the San Bernardino mountains, beyond which it seems not to extend.

Eutænia elegans vagrans.

Eutænia vagrans B. and G., Cat. No. Am. Serp., p. 35 (1853).[6]
Eutænia couchi Kenn., U. S. Pac. R. R. Surv., X, Pt. 4, p. 10 (1857).
Eutænia henshawi Yarrow, Proc. U. S. Nat. Mus., VI, p. 152 (1884).
E. elegans plutonia Cope, Proc. U. S. Nat. Mus., XIV, p. 653 (1892), and Rep. U. S. Nat. Mus., 1898, p. 1035.
E. elegans brunnea Cope, Proc. U. S. Nat. Mus., XIV, p. 654 (1892).
E. elegans lineolata (part) Cope, *l. c.*, p. 655.

This form ranges over the higher portion of the great plains, from whence it has penetrated through the valleys of the Snake and the Columbia rivers to the western coast. It is the garter snake of the Sierras and the Rocky mountains. I have taken it at 6,000 feet eleva-

[6] *Eutænia kennicotti* Jan (*Arch. Zool. Anat. and Phys.*, III, 1865, p. 216), with 21 rows and 8 labials, may belong here, but the description is vague, and the only locality given is northern United States.

tion in Montana, and two of the Academy's specimens were collected by Dr. Henry Skinner at Sapello, New Mexico, at an altitude of 10,000 feet.

The scutellation is similar to *E. e. elegans*, but the body is on an average larger and of stouter build. The head is larger and the eye relatively small.

The color is almost always greenish or light olive, with the pale yellow stripes narrow, not distinct, and often encroached upon by the small and ill-defined spots. An occasional example is brown, but *vagrans*, notwithstanding its extensive range, varies less than *elegans*. Usually there is a pair of dark nuchal blotches and the ventrals are more or less clouded with dark slate. While ordinary specimens are sufficiently distinct from *elegans*, there are intermediates in the western portion of its range, such as those called *E. e. lineolata* Cope, which reduce *elegans* and *vagrans* to the rank of subspecies.

No examples of *E. e. brunnea* Cope are known but the two types collected at Fort Bidwell, Cal. These anomalies might almost as well be regarded as *E. e. elegans*, but their robust build and the locality whence they came incline me to refer them to the present form.

The type of *E. couchi* Kenn. came from Pitt river, Cal., three hundred miles north of the known limit of *E. hammondi*, with which it has commonly been associated, and I agree with Van Denburgh in regarding the specimen as an anomalous *vagrans*.

There does not seem to be any reason to consider Cope's type of *E. e. plutonia*, from Walla Walla, Washington, as anything more than a melanistic *vagrans*. It is to be observed that Yarrow had already given the name of *E. henshawi* to this specimen, at the same time describing Cope's second example, from western Arizona, as *E. vagrans plutonia*.

Eutænia elegans biscutata.

Eutænia biscutata Cope, Proc. Acad. Nat. Sci. Phila., 1883, p. 21.

In western Oregon and Washington, and especially in the humid northwestern portion of the last state, *E. e. vagrans* is largely replaced by snakes generally similar but with a decided tendency toward melanism, and having usually two or three preoculars and sometimes 23 rows of scales. The types of *E. biscutata* were almost black and came from Klamath Lake, Ore., the most easterly locality from which it has been known, and where the rainfall is heavy. The association of these tendencies with a restricted area of distribution seems to require that it shall be recognized as a subspecies of *E. elegans*.

Eutænia sirtalis.

Coluber sirtalis L., Syst. Nat., Ed. X, p. 222 (1758).

The usual scutellation in this species is 19 rows and 7 upper labials, a formula which is very constant in the east, but in western forms 17 to 21 rows, or 6 to 8 labials sometimes occur. The lateral stripe is on the second and third rows. Compared with *E. elegans* it is larger and stouter, with a moderately large head. The posterior chin-shields are much longer than the anterior. East of the Mississippi river red is rarely developed, but I have seen one *E. s. sirtalis* from North Carolina which showed much of that color upon the sides, and another from Pennsylvania, in my own collection, is marked slightly with it on the flanks, but from the great plains westward there is a general disposition in reptiles to develop red, and it is more or less present in most subspecies of *E. sirtalis* from those parts.

Eutænia sirtalis parietalis.

Coluber parietalis Say, Long's Exp. to Rocky Mts., I, p. 186 (1823).
Coluber infernalis Blainville, Nouv. Ann. Hist. Nat., IV, 1835, p. 291, Pl. XXVI, fig. 3.
Tropidonotus concinnus Hallow., Proc. Acad. Nat. Sci. Phila., 1852, p. 182.
Eutænia dorsalis B. and G., Cat. No. Am. Serp., p. 31 (1853).
Eutænia ordinoides B. and G., *l. c.*, p. 33.
E. sirtalis tetratænia Cope (*Fide* Yarrow); U. S. Geol. Surv. W. of 100th Mer., V, p. 546 (1875), and Proc. U. S. Nat. Mus., XIV, p. 664.
E. sirtalis trilineata (part) Cope, Proc. U. S. Nat. Mus., XIV, p. 665 (1892).

E. s. parietalis has a range quite as wide as *E. c. vagrans*, for while it is absent from Arizona, and appears to be rare in Utah, it extends farther to the east on the plains. The scutellation is 19 rows and 7 labials, but now and then it has 8 labials, and more rarely 21 rows. It is ordinarily dark brown, with the spots more or less obscured and the lower row separated by red which shows on the skin and usually on the scales in life, though much of it quickly fades in spirits. The small dark spots on the ends of the ventrals and the dark margins to the labials are either present or absent. The belly is yellow, various shades of slate, or almost black in dark specimens. The outer row of scales is often smooth, but sometimes weakly keeled.

There is much difference in the amount and distribution of the red, especially in those from the Pacific coast, and there is a tendency toward melanism, strongly marked in the moist region of Oregon and Washington. In conformity with the law of color development in snakes this excess of pigment shows first upon the dorsal surface adjacent to the vertebral stripe, sometimes obscuring part or the whole of the upper row of spots (*E. dorsalis*); when it extends down far enough to reach the upper border of the lower row, these are left as

downward prolongations of the upper dark area, with red markings between (*E. parietalis*); when it extends to the lateral stripe all the spots are obliterated (*E. pickeringi*). A very few individuals show the bottom part of the lower row also obscured, leaving a series of red spots above (*E. concinna*); or the red has spread longitudinally, forming a red stripe between two black ones (*E. s. tetratænia*).

Of the above, the few specimens of *E. dorsalis* came from the Rio Grande valley, in New Mexico and Texas, except one fugitive noted by Cope from Portland, Ore., thirteen hundred miles away. Of the three *tetratænia* which Cope is able to name, two, in the U. S. National Museum, came from Pitt river, Cal., while the third, No. 6,085 in the Academy's collection, from Puget Sound, originally entered as *concinna*, has the lower black stripe broken up into spots anteriorly. A smaller snake in the same jar as this specimen, and apparently collected with it, is an ordinary *parietalis*. Hallowell's type of *Tropidonotus concinnus* (No. 6,324, Academy collection) is also marked on the label "*tetratænia*" by Cope. All these specimens have now been fifty years in spirits. The three *concinna* cited by Cope all came from western Oregon.

With the exception of *E. s. pickeringi*, these selections of special cases in a physiological process appear to me quite arbitrary, and if the correctness of the method is once admitted, an indefinite number of others may as well be allowed.

Baird and Girard's type of *Tropidonotus ordinoides*[7] came from Puget Sound, and the original description cannot be reconciled with that given of California specimens under the same name by these authors in their *Catalogue* of the following year. The type was probably an *E. s. leptocephala*. Those subsequently described had 19–21 rows of scales, and the chief difference from ordinary *parietalis* was that the lateral spots were reddish-brown instead of red. A California example is figured by Baird[8] with the form of head and the long posterior chin-shields of *parietalis*, and 8 labials, but as the last-named species sometimes exhibits this number, it seems safe to refer *ordinoides* here, rather than to regard it with Cope as a subspecies of *E. elegans*.

E. infernalis infernalis Cope has been shown to be *E. e. elegans*, but *Coluber infernalis* Blain. occupies a somewhat doubtful position through the insufficiency of the original description and plate. Bocourt[9] adds that it has 19 rows and 7 labials, which is the common formula for

[7] *Proc. Acad. Nat. Sci. Phila.*, 1852, p. 176.
[8] *Pac. R. R. Report*, Pl. XXVI, fig. 3.
[9] *Bull. Soc. Zool. de France*, 1892, p. 40.

parietalis, while his figures of Blainville's specimen[10] suggest this species rather than *elegans*; and as California examples of both these forms sometimes exhibit the *infernalis* style of coloring, I see no reason at present to regard Blainville's type as anything more than the present species.

Eutænia sirtalis pickeringi.

Eutænia pickeringi B. and G., Cat. No. Am. Serp., p. 27 (1853).
E. sirtalis trilineata (part) Cope, Proc. U. S. Nat. Mus., XIV, p. 665 (1892).

In the extreme west of Oregon and Washington, and especially about Puget Sound, a region of much moisture, melanism reaches an extreme and fairly constant degree in *E. s. pickeringi* B. and G. and *E. s. trilineata* Cope, the differences between which are trivial.[11]

E. s. pickeringi seems to be entitled to rank as a well-marked geographical form, always so dark as to obscure the spots, stripes usually narrow, very distinct and variable in color, occasionally a little red on the sides, and the ventral surface always more or less dark, sometimes entirely black.

Eutænia sirtalis leptocephala.

(?)*Tropidonotus ordinoides* B. and G., Proc. Acad. Nat. Sci. Phila., 1852, p. 176.
Eutænia leptocephala B. and G., Cat. No. Am. Serp., p. 29 (1853).
Eutænia atrata and *E. cooperi* Kenn., Pac. R. R. Surv., XII, Pt. 2, p. 296 (1860).
E. infernalis vidua Cope, Proc. U. S. Nat. Mus., XIV, p. 658 (1892).

This variable form is somewhat small in size and relatively stout; the head and eye are notably smaller than in other subspecies of *E. sirtalis*, and even more so than in *E. c. elegans*.

The rows of scales are 17 or 19, the outer either smooth or keeled; upper labials usually 7, but sometimes 6 or 8; preoculars occasionally 2 and in a few cases 3. Posterior chin-shields much longer than the anterior. The color is olive, greenish or blackish-brown, the three light stripes variable in color and sometimes absent; spots small and hardly to be seen in dark specimens; labials sometimes narrowly margined; parietal spots present; ventrals 139–152, yellow, greenish or dark slate. Some individuals with 19 rows and 7 labials so nearly resemble certain phases of *E. s. parietalis* or *E. s. pickeringi*, and in fact some eastern *E. s. sirtalis*, that I cannot regard it as more than a subspecies, occupying British Columbia, western Washington and Oregon and northern California.

E. cooperi Kenn. is clearly referable to this form. It has already been pointed out that the type of *Tropidonotus ordinoides* B. and G.

[10] *Miss. Sci. au Mexique*, etc., Pl. 55, figs. 2, 2*a*, 2*b*.
[11] Cope's examples of *trilineata* from Fort Benton, Montana, are probably *E. s. parietalis*.

(1852) was perhaps a *leptocephala*, but the fact cannot now be verified, and a mere possibility should not be allowed to disturb existing nomenclature.

E. infernalis vidua Cope was founded upon Kennicott's original specimens of *E. atrata*. One of these is now No. 6,359 (original number 970) in the collection of the Academy of Natural Sciences, and there is a second, No. 6,584, marked *vidua* in Cope's handwriting. Both of these specimens are labeled "San Francisco." I have elsewhere stated[12] that Cope's description is not accurate in details and have given my reasons for assigning these specimens to *leptocephala*. Mr. Van Denburgh considers them to be *E. e. elegans*, and states that this color form has been found only on the coast slope of the peninsula of San Francisco, and questions the occurrence of *leptocephala* in California. In consequence, I have reëxamined the two examples of *vidua* and am still inclined to refer them to *leptocephala*, leaving the geographical part of the problem for further investigation.[13]

In any event *vidua* would be no more than a synonym of *atrata*.

Eutænia hammondi.

Eutænia hammondi Kenn., Proc. Acad. Nat. Sci. Phila., 1860, p. 332.

Hammond's garter snake does not range north of Fresno county, Cal., but extends southeastward into the plains of Arizona.

The scutellation is that of *E. elegans*, but the body is slender, the head is narrow and elongated and the posterior chin-shields are much longer. The color is grayish or olive-brown; dorsal stripe narrow, indistinct or absent; the spots are always indistinct and sometimes absent, though indicated by black dots on many scales. Ventral surface yellowish, often with dark bases to the scuta, and at times clouded with slate toward the tail; this usually forms a line along the sutures between the subcaudals. Parietal spots and nuchal blotches present; labials dark bordered, and a more or less evident pale post-oral crescent.

This form has been regarded by some authors, including myself, as a subspecies of *E. elegans*, but further study of fresh material has satisfied me that it is distinct enough in character and geographical range to be admitted to specific rank.

[12] *Proc. Acad. Nat. Sci. Phila.*, 1901, p. 30.

[13] There may be a doubt as to the exact localities where the specimens on which *vidua* was founded were collected. Kennicott gave none in the original description of *E. atrata*, but in a footnote Dr. Cooper, the naturalist of the survey, says "California." The one in the Academy's collection is labeled "San Francisco," but there is also in the collection an undoubted *leptocephala* of about the same date, bearing a like label. San Francisco has always been the point at which all California interests center.

The only other name with which it has been confused is *E. couchi* Kenn., which has been shown to be in all probability an aberrant *E. e. vagrans*.

The geographical relations of the species here discussed are as follows: *E. e. elegans* meets with *E. e. vagrans* and *E. s. parietalis* throughout its range. At its southern extension it is overlapped by *E. hammondi* and at its northern it touches *E. s. leptocephala*. *E. e. vagrans* meets *E. hammondi* in California, and is in contact with *E. s. parietalis* almost everywhere except in Arizona, although the latter does not appear to ascend as high in the mountains. In the northwest it merges into *E. e. biscutata* and reaches *E. s. leptocephala*. On the plains it meets *E. radix*, and in the southwest comes more or less in touch with *E. marciana*, *E. eques* and perhaps *E. megalops*.

E. s. parietalis meets all of these except the last. In the east it overlaps scattering examples of *E. s. sirtalis* and probably *E. proxima*. In the far northwest it merges into *E. s. leptocephala* and *E. s. pickeringi*.

E. hammondi meets with *E. marciana* in the eastern part of its range in Arizona.

The connection between moisture and variability, especially in the direction of color intensity, may be profitably observed in these snakes.

More than a million square miles of the territory occupied by the widely ranging *E. e. vagrans* and *E. s. parietalis* lies east of the high mountain chains of the Pacific coast and has an annual rainfall of from 10 to 25 inches. Over this vast expanse the characters of these two species are very constant, and variation has contributed to the list of synonyms only *E. dorsalis* B. and G., in which melanism is in its earliest stage, and the one specimen of *E. henshawi* Yarr. (=*E. e. plutonia* Cope) from Walla Walla.

The region of great moisture, with a rainfall of from 50 to over 100 inches, occupies not more than a hundred thousand square miles, extending from latitude 40° in northern California to British Columbia. The type localities of the following five forms, characterized by pronounced melanism and often an excess of red, all fall within this restricted area: *E. ordinoides*, *E. concinna*, *E. pickeringi*, *E. s. tetratænia* and *E. s. trilineata*. In addition to these, *E. e. biscutata* and *E. s. leptocephala*, found there, also show marked tendencies to develop dark colors as well as instability in scutellation.

Five forms—*E. infernalis* Blain., *E. i. infernalis* Cope, *E. i. vidua*, *E. atrata* and *E. e. elegans*—were described from the neighborhood of San Francisco, where the actual rainfall does not exceed 25 inches,

but where much moisture is carried over the coast belt and up the river valleys by the persistent fogs which sweep in from the Pacific ocean.

The region occupied by *E. hammondi* is exceedingly dry, with a rainfall of less than 10 inches, and this species is relatively constant and is not known to show any tendency to melanism.[14]

[14] That humidity in some way influences the metabolic processes which lead to pigmentation can hardly be doubted. Temperature need scarcely be considered in the present case, for the dry region, extending from Arizona to northern Montana, and to considerable elevations, has a very great thermal range, while the wet region is relatively equable. There is a suggested connection between the large amount of uric acid produced by reptiles and the fact that the yellow and orange coloring matter from the wings of certain butterflies has yielded a substance closely related to uric acid, but physiological chemistry is not yet competent to explain how these waste products are converted into pigments.

The liberty to indulge in the striking colors developed in the garter snakes of this region is partly due to the protection afforded by luxuriant vegetation, and perhaps in some degree to the absence of the three snake-eating genera *Spilotes*, *Ophibolus* and *Elaps*.